Chem 101A Study Questions Name: _____
Chapters 7 & 8

Review Thursday 11/15/18 Due at Exam 4 TUESDAY 11/20/18

This is a homework assignment. Please show your work for full credit. If you do work on separate paper, attach the work to these.

Useful Info Provided on Exam 4:

$E = h\nu$ (ν is frequency)

$c = \lambda\nu$ (ν is frequency)

$$\Delta E = \frac{hc}{\lambda}$$

$$\lambda = \frac{h}{mv}$$ (v is velocity)

$$\Delta x \Delta(mv) \geq \frac{h}{4\pi}$$ (v is velocity)

$$E = -2.178 \times 10^{-18}\left(\frac{1}{n_{final}^2} - \frac{1}{n_{initial}^2}\right)$$

$h = 6.626 \times 10^{-34}$ J•s

$c = 2.9979 \times 10^{8}$ m/s

J = kg•m^2/s^2

TABLE 8.5 | Average Bond Energies (kJ/mol)

Single Bonds						Multiple Bonds	
H—H	432	N—H	391	I—I	149	C═C	614
H—F	565	N—N	160	I—Cl	208	C≡C	839
H—Cl	427	N—F	272	I—Br	175	O═O	495
H—Br	363	N—Cl	200			C═O*	745
H—I	295	N—Br	243	S—H	347	C≡O	1072
		N—O	201	S—F	327	N═O	607
C—H	413	O—H	467	S—Cl	253	N═N	418
C—C	347	O—O	146	S—Br	218	N≡N	941
C—N	305	O—F	190	S—S	266	C≡N	891
C—O	358	O—Cl	203			C═N	615
C—F	485	O—I	234	Si—Si	340		
C—Cl	339			Si—H	393		
C—Br	276	F—F	154	Si—C	360		
C—I	240	F—Cl	253	Si—O	452		
C—S	259	F—Br	237				
		Cl—Cl	239				
		Cl—Br	218				
		Br—Br	193				

*C═O(CO_2) = 799

1. When ignited, a uranium compound burns with a green flame. The wavelength of the light given off by this flame is greater than that of
   A) red light
   B) infrared light
   C) radio waves
   D) ultraviolet light
   E) none of these

2. Which of the following frequencies corresponds to light with the longest wavelength?
   A) $3.00 \times 10^{13}\ s^{-1}$
   B) $4.12 \times 10^{5}\ s^{-1}$
   C) $8.50 \times 10^{20}\ s^{-1}$
   D) $9.12 \times 10^{12}\ s^{-1}$
   E) $3.20 \times 10^{9}\ s^{-1}$

3. Green light can have a wavelength of 543 nm. The energy of a photon of this light is

4. Which one of the following types of radiation has the shortest wavelength, the greatest energy, and the highest frequency?
   A) Ultraviolet radiation.
   B) Infrared radiation.
   C) Visible red light.
   D) Visible blue light.
   E) None, because short wavelength is associated with low energy and low frequency, not high energy and high frequency.

Use the following to answer questions 5-8:

From the following list of observations, choose the one that most clearly supports the following conclusion:

   a) emission spectrum of hydrogen
   b) the photoelectric effect
   c) scattering of alpha particles by metal foil
   d) diffraction
   e) cathode "rays"

5. Electrons have wave properties.
   A) observation a
   B) observation b
   C) observation c
   D) observation d
   E) observation e

6. Electromagnetic radiation has wave characteristics.
   A) observation a
   B) observation b
   C) observation c
   D) observation d
   E) observation e

7. Electrons in atoms have quantized energies.
   A) observation a
   B) observation b
   C) observation c
   D) observation d
   E) observation e

8. Spacing between atoms in a crystal is on the same order as the de Broglie wavelength of accelerated electrons.
   A) observation a
   B) observation b
   C) observation c
   D) observation d
   E) observation e

9. In the hydrogen spectrum, what is the wavelength of light associated with the n=4 to n=1 electron transition? What type of EM radiation is this?

10. Bohr's model correctly describes the hydrogen atom and other small atoms.
    A) True
    B) False

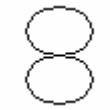
11. Which of the following statements best describes the Heisenberg uncertainty principle?
    A) The exact position of an electron is always uncertain.
    B) The velocity of a particle can only be estimated.
    C) It is impossible to accurately know both the exact location and momentum of a particle.
    D) The location and momentum of a macroscopic object are not known with certainty.
    E) The location and momentum of a particle can be determined accurately, but not the identity of the particle.

12. How many *d* orbitals have $n = 5$?
    A) 2
    B) 5
    C) 10
    D) 7
    E) 18

13. The *p* sublevel consists of _____ orbitals.
    A) 1
    B) 2
    C) 3
    D) 4
    E) 5

14. The number of orbitals having a given value of l is equal to
    A) $2l + 1$
    B) $2n + 2$
    C) $3l$
    D) $l + m_l$
    E) the number of lobes in each orbital

15. Consider the following representation of a 2*p*-orbital:



Which of the following statements best describes the movement of electrons in a *p*-orbital?

A) The electrons move along the outer surface of the *p*-orbital, similar to a "figure 8" type of movement.
B) The electrons move within the two lobes of the *p*-orbital, but never beyond the outside surface of the orbital.
C) The electrons are concentrated at the center (node) of the two lobes.
D) The electrons are only moving in one lobe at any given time.
E) The electron movement cannot be exactly determined.

16. True or False? The size of an orbital is arbitrarily defined.

A) True
B) False

17. How many electrons can be described by the quantum numbers $n = 3$, $l = 3$, $m_l = 2$?

A) 0
B) 2
C) 6
D) 10
E) 14

18. What is the *l* quantum number for a 4*s* orbital?

A) 1
B) 0
C) 3
D) 2
E) more than one of the above

19. How many electrons in an atom can have the quantum numbers $n = 4$, $l = 2$?

A) 14
B) 12
C) 5
D) 10
E) 6

20. Fe has _____ that is (are) unpaired in its d orbitals.
    A) one electron
    B) two electrons
    C) three electrons
    D) four electrons
    E) none of these

21. An neutral atom of an element has the electron configuration [Kr] $5s^2 4d^{10} 5p^2$. The element is a(n)
    A) nonmetal
    B) transition element
    C) metal
    D) lanthanide
    E) actinide

22. An element with the electron configuration [Xe] $6s^2 4f^{14} 5d^7$ would belong to which class on the periodic table?
    A) transition elements
    B) alkaline earth elements
    C) halogens
    D) rare earth elements
    E) none of the above

23. Which of the following atoms would have the largest second ionization energy? (*hint: core electrons*)
    A) Mg
    B) Cl
    C) S
    D) Ca
    E) Na

24. Consider the ionization energy (IE) of the magnesium atom. Which of the following is *not* true?
    A) The IE of Mg is lower than that of sodium.
    B) The IE of Mg is lower than that of neon.
    C) The IE of Mg is lower than that of beryllium.
    D) The IE of Mg is higher than that of calcium.
    E) The IE of Mg is lower than that of Mg^+.

25. Consider the following sets of quantum numbers. Which set(s) represent(s) impossible combinations? ***Explain your answers.***

	n	l	m_l
Set a	1	0	1
Set b	3	3	0
Set c	2	1	1
Set d	3	2	–2
Set e	3	1	–2
Set f	2	0	0

Use the following to answer questions 26-27:

Given the following electronic configuration of neutral atoms, identify the element and state the number of unpaired electrons in its ground state:

26. $[Ar]4s^1 3d^5$

27. $[Kr]5s^2 4d^{10} 5p^4$

Use the following to answer questions 28-30:

Choose the atom or ion using a periodic table.

28. Larger first ionization energy, Na or Rb

29. Larger first ionization energy, C or N

30. Larger atomic radius, P or Sb

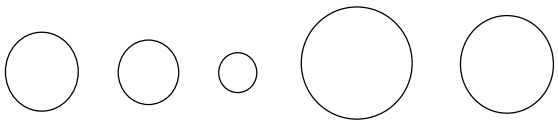
31. Calculate the lattice energy for LiF(*s*) given the following:

sublimation energy for Li(*s*)	+166 kJ/mol
bond energy for $F_2(g)$	+154 kJ/mol
first ionization energy of Li(*g*)	+520. kJ/mol
electron affinity of F(*g*)	–328 kJ/mol
enthalpy of formation of LiF(*s*)	–612 kJ/mol

32. Match the ions below with the pictures that represent their relative sizes. Justify your answers.

Ions:

Se^{2-} K^+ Ga^{3+} Br^- Ca^{2+}



note: gallium $3d^{10}$ electrons are core electrons

33. In which pair do both compounds exhibit predominantly ionic bonding?
    A) PCl_3 and HF
    B) Na_2SO_3 and BH_3
    C) KI and O_3
    D) CaF_2 and H_2O
    E) LiBr and MgO

34. A nonpolar covalent bond results from the unequal sharing of a pair of electrons between atoms in a molecule.
    A) True
    B) False

35. Choose the compound with the most ionic bond.
    A) LiCl
    B) KF
    C) NaCl
    D) LiF
    E) KCl

36. Which of the following bonds is least polar?
    A) C—O
    B) H—C
    C) S—Cl
    D) Br—Br
    E) They are all nonpolar.

37. Based on electronegativities, which of the following would you expect to be most ionic?
    A) N_2
    B) CaF_2
    C) CO_2
    D) CH_4
    E) CF_4

38. Metals typically have _____ electronegativity values.
    A) high
    B) low
    C) negative
    D) fuzzy
    E) two of these

39. Which of the following molecules has no dipole moment?
    A) CO_2
    B) NH_3
    C) H_2O
    D) all
    E) none

40. Which of these is an isoelectronic series?
    A) Na^+, K^+, Rb^+, Cs^+
    B) K^+, Ca^{2+}, Ar, S^{2-}
    C) Na^+, Mg^{2+}, S^{2-}, Cl^-
    D) Li, Be, B, C
    E) none of these (A-D)

41. Choose the molecule with the strongest bond.
    A) HF
    B) HCl
    C) HBr
    D) HI
    E) All are equal.

Use the following to answer questions 42-44:

Draw the Lewis structures of the molecules below and use them to answer the following questions:

I. BH_3
II. NO_2
III. SF_6
IV. O_3
V. PCl_5

42. Which of the molecules obeys the octet rule?
    A) I
    B) II
    C) III
    D) IV
    E) V

43. How many molecules are non-polar?
    A) 1
    B) 2
    C) 3
    D) 4
    E) They are all polar.

44. Which of these molecules show resonance?
    A) I, II
    B) II, IV
    C) II, V
    D) III, IV
    E) III, V

45. Using bond energies, calculate ΔH_{rxn} for the following equation. **Be sure to draw proper structures first!**

    $C_2H_2(g) + \frac{5}{2} O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$

46. Which of the following atoms cannot exceed the octet rule in a molecule?
    A) N
    B) S
    C) P
    D) I
    E) All of the atoms (A-D) can exceed the octet rule.

Use the following to answer questions 47-48:

Consider the following molecules.

I. BF_3
II. $CHBr_3$ (C is the central atom)
III. Br_2
IV. $XeCl_2$
V. CO
VI. SF_4

a) Draw each Lewis Structure.
b) Select the molecule(s) that fit the given statement.

47. These molecules violate the octet rule.
    A) I, II, IV
    B) I, III, IV, VI
    C) III, V, VI
    D) I, IV, VI
    E) I, II, IV, VI

48. These molecules are non-polar.
    A) III, V
    B) I, III, IV
    C) III, IV, V
    D) I, III, IV, VI
    E) none of them

49. When several similar Lewis structures can be drawn for a molecule, _____ is used to determine the most appropriate structure(s).

50. Which of the following species is best described by drawing resonance structures?
    A) PH_3
    B) NH_4^+
    C) O_3
    D) SO_3
    E) HCN

51. Choose the electron dot formula that most accurately describes the bonding in CS_2.
    A) :S=C=S:
    B) :C=S=S:
    C) :S—C—S:
    D) :S—C=S:
    E) :S—C≡S:

52. Which of the following ionic compounds should have the smallest magnitude lattice energy (i.e., the lattice energy <u>least favorable</u> to a stable lattice or <u>least exothermic</u>)? *hint: See Coulomb's Law*
    A) LiF
    B) CsI
    C) NaCl
    D) BaO
    E) MgO

53. According to the VSEPR model, the arrangement of <u>electron pairs</u> around NH_3 and CH_4 is
    A) different, because in each case there are a different number of atoms around the central atom
    B) different, because in each case there are a different number of electron pairs around the central atom
    C) the same, because both nitrogen and carbon are both in the second period
    D) the same, because in each case there are the same number of electron pairs around the central atom
    E) different or the same, depending on the conditions leading to maximum repulsion

Use the following to answer questions 54-61:

1) Draw each Lewis structure (including any/all lone pairs).
2) Determine VSEPR geometry for each structure.

54. $BeCl_2$

55. NO_3^-

56. PF_5

57. SF_4

58. PF_5

59. BrO_4^-

60. SF_6

61. NI_3

62. The bond angle about the central atom of $SOCl_2$ is
    A) <109.5°
    B) 120°
    C) 90°
    D) 180°
    E) None of these

63. The bond angle about the central atom of BrF_6^+ is
    A) 180°
    B) 120°
    C) 90°
    D) 109.5°
    E) None of these

64. The bond angle about the central atom of XeF_5^+ is
    A) 180°
    B) 90°
    C) 45°
    D) 120°
    E) none of these

65. The bond angles about the carbon atom in the formaldehyde molecule, $H_2C{=}O$, are about:
    A) 120°
    B) 60°
    C) 109°
    D) 180°
    E) 90°

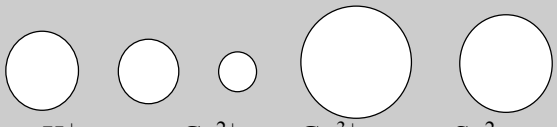
66. The bond angle in H_2Se is about:
    A) 120°
    B) 60°
    C) 180°
    D) 109°
    E) 90°

67. Sketch the Born-Haber cycle and calculate ΔH_f for NaBr(*s*), given the following information:

    Na(s) ΔH_{sub} = 109 kJ/mol
    First Ionization Energy Na = 496 kJ/mol
    $Br_2(l)$ ΔH_{vap} = 30.0 kJ/mol
    Br_2 bond energy = 193 kJ/mol
    Electron Affinity Br = -324.5 kJ/mol
    Lattice Energy NaBr(s) = -736 kJ/mol

Answer Key

1.	D
	Chapter/Section: 7.1
2.	B
	Chapter/Section: 7.1
3.	3.66×10^{-19} J
	Chapter/Section: 7.2
4.	A
	Chapter/Section: 7.2
5.	D
	Chapter/Section: 7.2
6.	D
	Chapter/Section: 7.2
7.	A
	Chapter/Section: 7.3
8.	D
	Chapter/Section: 7.2
9.	9.73×10^{-8} m UV
	Chapter/Section: 7.4
10.	B
	Chapter/Section: 7.4
11.	C
	Chapter/Section: 7.5
12.	B
	Chapter/Section: 7.6
13.	C
	Chapter/Section: 7.6
14.	A
	Chapter/Section: 7.6
15.	E
	Chapter/Section: 7.7
16.	A
	Chapter/Section: 7.7
17.	A
	Chapter/Section: 7.8
18.	B
	Chapter/Section: 7.8
19.	D
	Chapter/Section: 7.8
20.	D
	Chapter/Section: 7.11
21.	C
	Chapter/Section: 7.11
22.	A

	Chapter/Section: 7.11
23.	E
	Chapter/Section: 7.12
24.	A
	Chapter/Section: 7.12
25.	Sets a, b, and e represent impossible combinations. Set a is impossible because m_l can only have values from $-l$ to $+l$. If l is 0, m_l can only be 0. Set b is impossible because l can only have values from 0 to n-1. When $n = 3$, l may be only 0, 1, or 2. Set e is impossible because m_l can only have values from $-l$ to $+l$. If l is 1, m_l can only be -1, 0, or +1. See Sec. 7.6 in Zumdahl *Chemistry*.
	Chapter/Section: 7.6
26.	The element is Cr with six unpaired electrons in its ground state.
	Chapter/Section: 7.11
27.	The element is Te with two unpaired electrons in its ground state.
	Chapter/Section: 7.11
28.	Na
	Chapter/Section: 7.12
29.	N
	Chapter/Section: 7.12
30.	Sb
	Chapter/Section: 7.12
31.	–1047 kJ/mol
	Chapter/Section: 8.5
32.	 Se^{2-} and Br^- each have the electron configuration of Kr. K^+, Ca^{2+}, and Ga^{3+} each have the electron configuration of Ar. The Se^{2-} and Br^- contain electrons in a higher energy level, therefore making their radii larger than the other three ions. Since Br^- has more protons, this will draw the electrons in slightly more than Se^{2-} (due to a slightly higher effective nuclear charge). For the other three ions, Ga^{3+} will be the smallest because it has the highest number of protons. K^+ has the least number of protons and is thus the biggest ion of the three. See Sec. 8.4 in Zumdahl, *Chemistry*.
	Chapter/Section: 8.4
33.	E
	Chapter/Section: 8.1
34.	B
	Chapter/Section: 8.1

35.	B
	Chapter/Section: 8.2
36.	D
	Chapter/Section: 8.2
37.	B
	Chapter/Section: 8.2
38.	B
	Chapter/Section: 8.2
39.	A
	Chapter/Section: 8.3
40.	B
	Chapter/Section: 8.4
41.	A
	Chapter/Section: 8.8
42.	D
	Chapter/Section: 8.10
43.	C
	Chapter/Section: 8.13
44.	B
	Chapter/Section: 8.12
45.	–1228 kJ
	Chapter/Section: 8.8
46.	A
	Chapter/Section: 8.11
47.	D
	Chapter/Section: 8.11
48.	B
	Chapter/Section: 8.13
49.	formal charge
	Chapter/Section: 8.12
50.	C
	Chapter/Section: 8.12
51.	A
	Chapter/Section: 8.12
52.	B
	Chapter/Section: 8.5
53.	D
	Chapter/Section: 8.13
54.	linear
	Chapter/Section: 8.13
55.	trigonal planar
	Chapter/Section: 8.13
56.	none of above
	Chapter/Section: 8.13
57.	see-saw
	Chapter/Section: 8.13

58.	trigonal bipyramid
	Chapter/Section: 8.13
59.	tetrahedral
	Chapter/Section: 8.13
60.	octahedral
	Chapter/Section: 8.13
61.	trigonal pyramidal
	Chapter/Section: 8.13
62.	A
	Chapter/Section: 8.13
63.	C
	Chapter/Section: 8.13
64.	B
	Chapter/Section: 8.13
65.	A
	Chapter/Section: 8.13
66.	D
	Chapter/Section: 8.13
67.	Hints: See example Fig 8.9 pg 366 text. Also, since ΔH_f is for 1 mole NaBr(*s*), you need to multiple a couple of the energies proved by 1/2. Which ones?